

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of Eiju SUZUKI, et al.

Application No.: 10/562,947

Filed: March 13, 2008

For: RUBBER COMPOSITION AND TIRE USING THE SAME

Group Art Unit: 1791

Examiner: Justin R. Fischer

Confirmation No.: 8599

DECLARATION UNDER 37 C.F.R. § 1.132

I, Eiju Suzuki, declare that:

I am one of the inventors of the above-captioned patent application.

I received my Master of Science and Technology from Keio University in 2002, and have been employed by Bridgestone Corporation since 2002, where I have been engaged mainly in research and development of new polymers.

I have made the following experiments in order to evaluate the processability, the wear resistance and the durability of the rubber composition comprising as a rubber component (A) a synthetic polyisoprene rubber having a cis-1,4-bond content of slightly above 99.0% (Polyisoprene rubber D), or having a cis-1,4-bond content of slightly below 99.0% (Polyisoprene rubber E) and (B) a natural rubber, wherein a ratio by mass of (A) the synthetic polyisoprene rubber to a total of (A) the synthetic polyisoprene rubber and (B) the natural rubber is 5-60 mass%.

Experimental Procedure

<Synthesis of Polyisoprene rubber D>

A polyisoprene rubber is synthesized in the same manner as in the Production Example 1 of Polyisoprene disclosed in paragraph [0028] in the specification of the present application except that a polymerization temperature is -10°C. As a result of the synthesis, 39.3 g of a polyisoprene rubber D is obtained in a yield of 92%. In the polyisoprene rubber D, the number average molecular weight (Mn) by a GPC is 975,100 and Mw/Mn is 1.97. As the

micro-structure is determined from an integration ratio of 15.5-16.5 ppm (1,4-trans unit), 18.0-19.0 ppm (3,4-unit) and 23.0-24.0 ppm (1,4-cis unit), the cis-1,4-bond content is 99.1%, the trans-1,4-bond content is 0% and the 3,4-bond content is 0.9%.

<Synthesis of Polyisoprene rubber E>

A polyisoprene rubber is synthesized in the same manner as in the Production Example 1 of Polyisoprene disclosed in paragraph [0028] in the specification of the present application except that a polymerization operation is conducted in a water bath wherein a temperature is about 10°C (lowest temperature: 9°C, highest temperature: 12°C). As a result of the synthesis, 38.2 g of a polyisoprene rubber E is obtained in a yield of 90%. In the polyisoprene rubber E, the number average molecular weight (Mn) by a GPC is 841,200 and Mw/Mn is 2.10. As the micro-structure is determined from an integration ratio of 15.5-16.5 ppm (1,4-trans unit), 18.0-19.0 ppm (3,4-unit) and 23.0-24.0 ppm (1,4-cis unit), the cis-1,4-bond content is 98.9%, the trans-1,4-bond content is 0% and the 3,4-bond content is 1.1%.

(Additional Comparative Examples J, K, L and M)

<Preparation of Rubber composition>

By using the above described polyisoprene rubber D or E, a rubber composition is prepared according to a compounding recipe shown in the following Table D.

<Evaluation of properties of rubber composition>

With respect to the resulting rubber compositions, the processability, wear resistance and durability of the rubber composition are evaluated according to the methods described in paragraphs [0032]-[0034] in the specification of the present application. Results obtained from these experiments are summarized in the following Table D.

Moreover, Table C disclosed in my declaration filed on May 3, 2010 is shown below again for the purpose of reference.

Table D

		Additional Comparative Example J	Additional Comparative Example K	Additional Comparative Example L	Additional Comparative Example M	Comparative Example 6
Formulation	Natural rubber (RSS#3)	95	40	95	40	100
	Polyisoprene rubber D *7	5	60	-	-	-
	Polyisoprene rubber E *8	-	-	5	60	-
	Carbon black *4	50	50	50	50	50
	Stearic acid	2	2	2	2	2
	Antioxidant 6C *5	1	1	1	1	1
	Zinc oxide	3	3	3	3	3
	Vulcanization accelerator DZ *6	0.8	0.8	0.8	0.8	0.8
	Sulfur	1	1	1	1	1
	Processability	104	122	104	119	100
Evaluation	Wear resistance	100	92	100	91	100
	Durability	94	80	94	78	100

*7 The polyisoprene rubber synthesized as described above, cis-1,4-bond content=99.1%, 3,4-bond content=0.9%.

*8 The polyisoprene rubber synthesized as described above, cis-1,4-bond content=98.9%, 3,4-bond content=1.1%.

*4 N339, made by Tokai Carbon Co., Ltd. N₂SA=93m²/g.

*5 N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylenediamine, made by Ohuchi Shinkou Kagaku Co., Ltd., Nocrac 6C.

*6 N,N'-dicyclohexyl-2-benzothiazolyl sulfenamide, made by Ohuchi Shinkou Kagaku Co., Ltd. Noccler DZ.

Table C

		Additional Example A	Additional Comparative Example F	Additional Comparative Example G	Additional Example B	Additional Comparative Example H	Additional Comparative Example I	Comparative Example 6
Formulation	Natural rubber (RSS#3)	95	95	95	40	40	40	100
	Polyisoprene rubber A *1	5	-	-	60	-	-	-
	Polyisoprene rubber B *2	-	-	5	-	-	60	-
	Polyisoprene rubber C *3	-	5	-	-	60	-	-
	Carbon black *4	50	50	50	50	50	50	50
	Stearic acid	2	2	2	2	2	2	2
	Antioxidant 6C *5	1	1	1	1	1	1	1
	Zinc oxide	3	3	3	3	3	3	3
	Vulcanization accelerator DZ *6	0.8	0.8	0.8	0.8	0.8	0.8	0.8
	Sulfur	1	1	1	1	1	1	1
Evaluation	Processability	108	104	103	140	124	117	100
	Wear resistance	101	100	100	98	94	91	100
	Durability	97	94	93	90	82	77	100

*1 Produced by the Production Example 1 of Polyisoprene described in paragraph [0028] in the specification of the present application, cis-1,4-bond content=99.6%, 3,4-bond content=0.4%.

*2 IR2200, made by JSR Corporation, cis-1,4-bond content=98.0%, 3,4-bond content=2.0%.

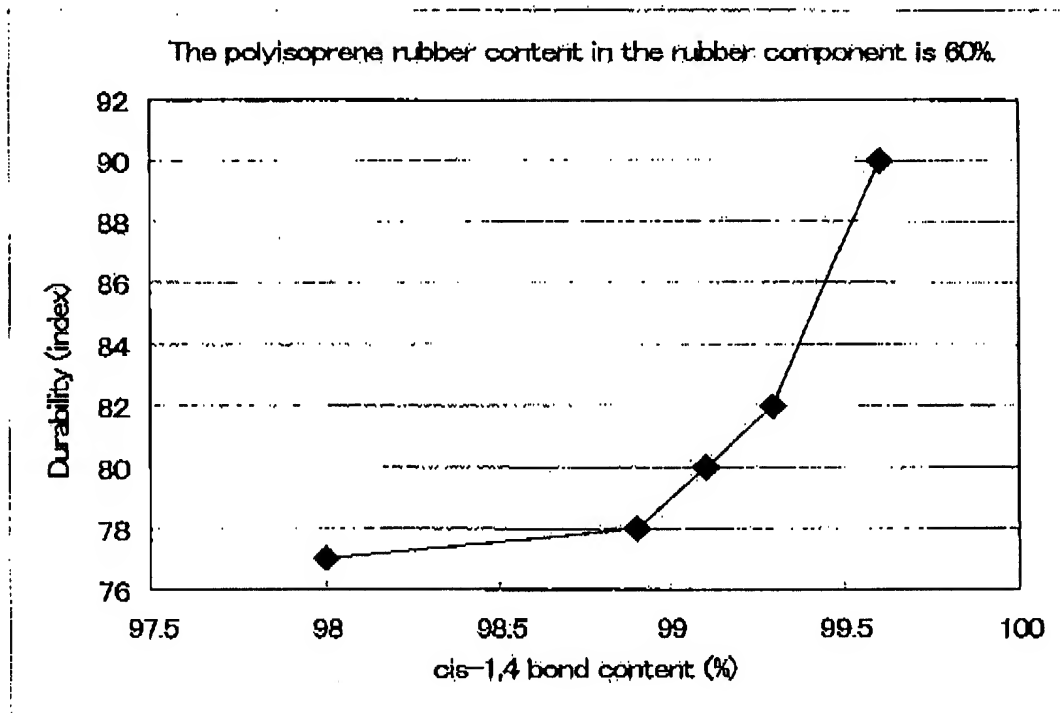
*3 Produced through the method described in my declaration filed on January 13, 2010, cis-1,4-bond content=99.3%, 3,4-bond content=0.7%.

*4 N339, made by Tokai Carbon Co., Ltd. N₂SA=93m²/g.

*5 N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylenediamine, made by Ohuchi Shinkou Kagaku Co., Ltd., Nocrac 6C.

*6 N,N'-dicyclohexyl-2-benzothiazolyl sulfenamide, made by Ohuchi Shinkou Kagaku Co., Ltd. Nocsler DZ.

Further, the results of the durability of each rubber composition are shown in the following graph.



(Summary)

As seen from the above results, when the 1,4-bond content of the polyisoprene rubber exceeds 99%, the durability of the rubber composition is improved.

Further, when the 3,4-bond content is not more than 0.5%, the durability of the rubber composition is highly improved as seen from the results of Additional examples A and B in Table C.

I declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under § 1001 of Title 18 of the United States Code and that such willful false statements may

jeopardize the validity of the application or any patent issuing thereon.

Date: 2-4-2011

Declarant: 
Eiju Suzuki